Electro-Technology

ANNOTATED EDITORIAL INDEX

1961

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Contents

Subject Index 2
Science and Engineering 2
Components, Electrical/Engineering 3
Components, Mechanical/Structural 6
Computing Machines 6
Design Considerations 6
Heat Flow 8
Instruments and Test Equipment 8
Materials, Electrical/Electronic 8
Materials, Mechanical/Structural 9
Motors 10
Production and Assembly Techniques 11
Specifications and Standards 11
Systems 11
Test and Measurement 12
Research Notes 13
Editorials 13
Design Trends 14

Authors' Index 15
Alphabetical Subject Cross Index 20
Editorial Subject Classification 22

Subject Classification	Month	Page
SCIENCE AND ENGINEERING		
Cryogenics: Environment/Phenomena/Applications, A. E. Javitz A state-of-the-art examination of the science and technology of cryogenics, particularly from the viewpoint of the impact on the design of electrical/electronic devices, equipment and systems. Effects of environment and induced phenomena on fundamental properties and behavior of materials are discussed and appropriate data given. Examples of cryogenic design are described. The first of a two-part series on the subject.	Sep	121
Wear of Materials—Impact on Design Failure, H. E. Barkan A study of the basic concepts of wear of materials, based on the results obtained from the observation of wear in metals. Descriptions of the phenomenon of wear as applied to design engineering are discussed. Wear and its minimization are examined and reported. The text is supported by tables and an extensive bibliography.	Jul	95
Engineering Psychology and Human Factors in Design, Members of the Research Staff, Dunlap and Associates, Inc., and A. E. Javitz Engineering psychology is considered as a primary experimental research arm of human-factors engineering. Fundamental areas of the subject are discussed with relevance to equipment and systems-design parameters. The basic concept is that of the man-machine-environment interactions and the ultimate reliability of system performance.	May	107
Mathematics		
Analytic Functions of a Complex Variable, N. P. Salz Review of complex numbers; operations and algebraic laws, mapping, absolute value and phase, the algebra and trigonometry of complex numbers and the roots of complex numbers. Functions of a complex variable; definition of terms for the study of functions, limits, continuity, differentiation, the Cauchy-Riemann conditions and polar coordinates. Analyticity, the harmonic functions and the Laplace equation. Line integrals in simply and multiply connected regions, Green's theorem, the Cauchy-Goursat integral theorem and Cauchy's integral formula. Infinite series of complex numbers, the Laurent series, the theory of residues and the Laplace transform integral solution for poles and residues.	Nov	93
Hyperbolic Functions, A. D. Kraus The hyperbolic functions and the inverse hyperbolic functions are defined entirely in terms of the ascending exponential function e^x and the descending exponential function e^{-x}. All algebraic and trigonometric properties and their associated operations are derived from the basic definitions. The utility of the hyperbolic functions is demonstrated in solutions of the classical transmission-line problem.	Oct	87
A Band-Pass Filter Slide Rule, A. I. Zverev and H. J. Blinchikoff In designing filters by the image-parameter method, it is usually impractical to draw curves for all possible conditions. Here is a usable slide rule for making the necessary calculations to design band-pass filters. Insertion losses and attenuations may be quickly determined with its use.	Sep	136
Tensor Analysis, M. L. Boas and J. J. Hupert The generalized basis of vector and scalar concepts, tensor analysis, is defined and explored for its engineering usefulness. Examples, selected references and bibliography are included.	Aug	85
Vector Analysis, M. L. Boas and J. J. Hupert Rigorous definitions of scalar and vector functions and fields, and their properties, are established. Primary vector laws, transformation and matrix methods are then developed, with application illustrations.	Jun	91
Probability, Statistics, and The Theory of Games, L. S. Schwartz and A. M. Hilton Basic patterns, laws and mathematical models revolving around the theory of probability fundamental to any field of application: permutations and combinations, probability of events occurring in a sample space, distributions, random variables, the Law of Large Numbers, averaging, estimation, random processes, correlation theory, spectral analyses, the Gaussian process, construction of tests, games theory.	Mar	101
Reliability through Redundancy and Error-Correcting Codes, L. S. Schwartz The problem of reliability assumes serious proportions whenever numerous hardware components and transmission of large amounts of data of informational and control nature are involved. Beyond the very definite limits of components improvement, the problem must be attacked by using redundant components and circuits. Principles of redundancy in equipment and coding in data transmission are discussed; examples illustrating applications are given.	Feb	123
Bessel and Gamma Functions, A. D. Kraus Bessel's equation and the Bessel functions, recurrence relationships, and the generalized form of Bessel's equation are presented. The gamma function, the solution to Bessel's equation, and the method for deducing recurrence relationships, or basic identities, are given. The values of Bessel's zero- and first-order functions of the first and second kind (both ordinary and modified) and gamma functions are tabulated.	Jan	74

Subject Classification	Month	Page
Network Analysis		
Thermistor-Resistor Temperature-Sensing Networks, O. Schwelb and G. C. Temes ..... A procedure for the design of networks (either four-pole or two-pole) consisting only of resistors and a thermistor for use in temperature-sensing applications. The thermistor may have either a negative or a positive temperature coefficient. Extensive tables give design parameters.	Nov	71
Hyperbolic Functions, A. D. Kraus ..... The hyperbolic functions and the inverse hyperbolic functions are defined entirely in terms of the ascending exponential function e^x and the descending exponential function e^{-x}. All algebraic and trigonometric properties and their associated operations are derived from the basic definitions. The utility of the hyperbolic functions is demonstrated in solutions of the classical *transmission-line problem.*	Oct	87
Digital-Circuit Reliability through Redundancy, A. A. Sorensen ..... A summary of results obtained by the application of redundancy to various types of digital circuits used in computers. Both part and circuit redundancy are applied, and comparisons are made between various possible techniques. Formulas are derived which enable the designer to ascertain the actual reliability improvements to be expected from redundancy.	Jul	118
A Procedure for the Design of Transistor Bias Networks, G. E. Platzer, Jr..... ..... By using a few simple equations and two easily obtained graphs, the values of biasing resistors which will provide suitable temperature stability of the operating point are readily calculated. Methods used in arriving at the equations for the networks discussed can be used for other bias schemes as well.	Apr	97
Reliability through Redundancy and Error-Correcting Codes, L. S. Schwartz..... The problem of reliability assumes serious proportions whenever numerous hardware components and transmission of large amounts of data of informational and control nature are involved. Beyond the very definite limits of components improvement, the problem must be attacked by using redundant components and circuits. Principles of redundancy in equipment and coding in data transmission are discussed; examples illustrating applications are given.	Feb	123
Network Synthesis: Some Notes on the Synthesis of *RLC* Transfer Functions and Constant-Resistance All-Pass Lattice Networks, L. Weinberg ..... The basic principles of network synthesis (as presented in Dr. Weinberg's Science & Engineering article in the January 1961 issue of ELECTRO-TECHNOLOGY) are applied to the synthesis of *RLC* transfer functions and constant-resistance all-pass lattice networks.	Feb	135
Introduction to Network Synthesis, L. Weinberg Basic characteristics of network synthesis are presented and synthesis for *optimum* results and *exact* solutions is demonstrated. Frequency-domain synthesis of passive lumped-constant networks is stressed. Includes synthesis of simple driving-point functions by recognition, realizability conditions, approximation of a given curve by an appropriate rational function, related problems.	Jan	85
Semiconductor Electronics 4—Transistor Network Analysis, A. A. Sorensen ..... General four-terminal networks are analyzed in terms of the various possible parameters. The same techniques are then applied to transistor circuits. Properties of common-base, common-emitter, and common-collector connected transistors are developed. (The fourth in a six-part series.)	Jan	105
Physics		
Electrical Breakdown in Solids and Liquids, A. H. Sharbaugh and J. C. Devins..... The basic concepts of electrical breakdown, previously examined by the authors in relation to gases (*cf* February 1961 issue of ELECTRO-TECHNOLOGY), are now extended to considerations of breakdown phenomena in solids and liquids. Experimental studies are discussed and various theories of breakdown are elucidated, in some instances with the use of mathematical examples.	Oct	97
Quantum Electronics, G. C. Dacey ..... Quantum theory as related to solid-state physics is explained for the benefit of the practicing electrical design engineer, starting with Planck's radiation theory, Bohr's concept of the atom, and de Broglie's hypothesis of wave-particle duality, the heart of quantum mechanics. The wave equation is related to the Schrödinger equation. Other aspects considered include observables and operators, eigen functions and eigen values, the indeterminacy principle.	Apr	109
The Fundamental Nature of Electrical Breakdown, J. C. Devins and A. H. Sharbaugh ..... An exposition of the various aspects of the subject for the systems and design engineer, including classical concepts of the mechanisms of breakdown, the effects of time lags, the influence of variables, and the relationships between breakdown and the nature of the dielectric (primarily electron behavior and molecular structure). A minimum of mathematics is employed, with physical illustrations and analogies being used as much as possible.	Feb	103
Network Synthesis: Some Notes on the Synthesis of *RLC* Transfer Functions and Constant-Resistance All-Pass Lattice Networks, L. Weinberg ..... The basic principles of network synthesis (as presented in Dr. Weinberg's Science & Engineering article in the January 1961 issue of ELECTRO-TECHNOLOGY) are applied to the synthesis of *RLC* transfer functions and constant-resistance all-pass lattice networks.	Feb	135
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Systems		
Electromechanical Energy Conversion, P. L. Alger and E. Erdelyi ..... The behavior of electric machines in power and control systems is analyzed from the standpoint of energy flow. Performance equations, equivalent circuits for dynamic components and both steady-state and transient problems are considered, with solutions.	Sep	95
COMPONENTS, ELECTRICAL/ELECTRONIC		
All Classifications		
Key Problems in Microelectronics, A. E. Javitz An objective examination of the current problems in large-scale development and use of microelectronic devices. The discussion is in terms of materials, techniques, reliability, yields, costs, standards, and design integration.	Jun	61
Summary of Nuclear Radiation Effects on Electronic Components and Systems, J. E. Drennan and E. N. Wyler ..... A "state of the art" summary of current knowledge of the effects of different types of nuclear radiation on components and systems. Reports cover electron tubes, resistors, capacitors, relays, switches, terminals, transformers, transistors, semiconductor diodes and electronic systems. A supporting bibliography is also given.	Mar	132
Analyzing Failure Rates in Electronic Components, G. W. A. Dummer..... Variables in component manufacture and ap-	Feb	89

plication impose difficulties on accurate statistical analysis of reliability. Typical faults caused by such variables are discussed. Failure data for specific equipments under given operating and environmental conditions are presented.

Batteries

Electrochemical Energy Sources—Nickel/Cadmium Batteries, R. W. Schult and W. T. Stafford ..... Jul 87
The properties, reactions, design and operation of nickel/cadmium batteries in powering control systems and components for missile and space vehicles are studied. Characteristics of these batteries are given in charts and tables. This study is a follow-up of the preceding article (June 1961) on silver oxide/zinc batteries and basic technology of galvanic power sources.

Electrochemical Energy Sources—Silver Oxide/Zinc Batteries, R. W. Schult and W. T. Stafford ..... Jun 84
The characteristics of silver oxide/zinc batteries are studied with respect to operating and design parameters in powering control systems and components for missile and space vehicles. Several types of these galvanic power sources are analyzed and classified for adoption into an operation system. Charts and tables evaluate characteristics of these batteries.

Contact Devices

Mechanics of Electrical-Contact Failure Caused by Surface Contamination, S. W. Chaikin ..... Aug 70
A study of the reasons for failure of contacts in electrical connecting devices, particularly sealed relays. Primary interest is in contaminants deposited on the contact surface in the form of base metal and organic contamination. This report details contaminating sources, materials and methods for their control.

Relay Designers and Users Meet, M. M. Meyers Jul 74
A summary report on the Ninth National Conference on Electromagnetic Relays, held April 24–27, 1961 at Oklahoma State University. Nine technical papers are reviewed. Covered are relay contact failure, special telephone-relay contacts, contact spring for reduced chatter in high-speed relays, high-speed relay operation with minimal power, dry-reed relay logic device, r-f interference suppression, and test and measurement.

Drive Developments Stressed at Machine Tool Forum, Staff Report ..... Jun 119
Digest of selected papers presented at the 25th Westinghouse Machine Tool Forum. New drives and modifications of others are described, along with user experience with them. Small *relays* are evaluated and systems implications analyzed.

A Method for Experimental Study of Relay Stability, C. F. Cameron, D. D. Lingelbach and C. C. Freeny ..... Mar 156
In the design of use of a relay or similar device, it is desirable to know the effects on performance of changes in key variable conditions and parameters. An experimental method is described for evaluating the effects of such changes for a relay.

Embedded Circuits

Thermally Conductive Cast-Resin Compounds for Heat Dissipation, C. A. Harper ..... Apr 148
Cast-resin embedments for electronic packaging can provide satisfactory heat dissipation by utilizing resin compounds of sufficiently high thermal conductivity. This article describes the effect of various compound fillers that improve conductivity and discusses the nature and significance of filler properties and characteristics. Thermal conductivity data are applied to specific design problems.

Subject Classification | Month | Page

Magnetic Components

Automatic Switching Control with Electric Clutches and Brakes, P. Block and D. Hennings ..... Dec 84
Torque-slip characteristics, average torque curves, thermal rating and flux build-up and decay times are considered for direct-acting, friction-disk electromagnetic clutches and brakes for mechanical power-switching functions. Control devices are reviewed and basic control circuits illustrated, including methods of providing overexcitation and underexcitation. General-purpose transistor control.

Transformer Specification for Reliable Electronic Equipment, D. Epstein ..... Oct 76
Specification MIL-T-27A is interpreted and the need for additional information detailed with respect to environmental conditions, electrical requirements and mechanical considerations to aid the systems or subsystems designer in getting his requirements met by the transformer manufacturer.

A-C Solenoid Application, I. Gebel ..... Oct 117
In selecting an a-c solenoid, there must be a proper balance between application requirements and inherent solenoid characteristics. A procedure is developed for selecting, as closely as possible, the correct solenoid for a particular application. Several examples illustrating the procedure are given.

Graphical Flux Analysis in Transformer Design, M. G. Leonard ..... Oct 122
Examples of the quantitative use of field-mapping techniques are presented, and their application to transformer design problems detailed.

Optimal Electromagnet Design, T. Lindstrom .... Sep 144
The inadequacy of the "ampere-turn" concept in electromagnet design is demonstrated. The use of the more significant current linkage factor is illustrated by design examples.

Wound Cores Improve Transformer Performance, C. Ghaznavi ..... Jun 67
The reasoning underlying a new three-phase transformer design using circular wound cores is given. Test data showing improvements over E-core equivalent designs are included.

Designing Electronic Transformers on a Digital Computer, R. Lee ..... May 147
To demonstrate the iterative procedures used to optimize the design of small electronic transformers within limits of overall performance, the computer programming for a single-secondary transformer in the range of 4 to 3230 va core rating is detailed. Modifications of the program for designing rectifier-plate transformers and linear inductors are also described.

Design of a Magnetic Voltage Stabilizer, S. Lindena May 154
The principles of operation of the magnetic voltage stabilizer are related. Design details with a specific example are included.

The Technique of Transformer Design, I. Richardson ..... Jan 58
A rational approach to power transformer design is derived from basic magnetic and electrical principles. Detailed electrical and thermal design aspects are discussed, with examples. Transformers for rectifier circuits are stressed.

Microcircuit Assemblies

Thermal Design Considerations in Thin-Film Microelectronics, J. R. Baum ..... Jul 92
Analysis of problems associated with adequate thermal design in thin-film devices. Problem is examined with two considerations in mind: thermal characteristics of individual circuit elements and the modes of heat transfer and temperature gradients in substrate assembly concepts.

Key Problems in Microelectronics, A. E. Javitz Jun 61
An objective examination of the current problems in large-scale development and use of

Subject Classification	Month	Page
microelectronic devices. The discussion is in terms of materials, techniques, reliability, yields, costs, standards, and design integration.		
Superconductive Circuits for Computing Machines, V. L. Newhouse ..... Gain and time constants of wire-wound and film-type cryotrons are compared. Cross-film types function as logic circuit elements. Because the cost and bulk of deposited crossed-film cryotrons is considerably below that of transistors and they dissipate only about 1/1000 that of transistor energy, their use in extremely compact digital computer systems of high speed is foreseen.	Apr	78
Microwave Components		
Trends in Semiconductor Devices for Microwave Applications, M. Tenzer ..... A review of the latest developments in transistors, diodes, tunnel diodes, parametric amplifiers, etc. Specific information on the capabilities of various types at microwave frequencies.	Oct	82
Microwave Filters, E. N. Torgow ..... The present state-of-the-art of microwave filter design is examined. The various techniques available for designing filters are described and their advantages and limitations are considered. Examples are included.	Apr	90
Power Sources		
Unconventional Power Sources—2, E. Randall .. Theory, electrical characteristics, and state of the art of thermionic converters, solar cells, magnetohydrodynamics, photoemissive generators, ferroelectric converters, and devices utilizing the Austin effect. (Covered in Part 1 were fuel cells and thermoelectric devices.)	Sep	85
Unconventional Power Sources—1, E. Randall .. A survey of the various types of "exotic" power sources that are being developed particularly for use in space vehicles. Special emphasis on electrical characteristics, efficiencies, power-to-weight ratios, etc. Covered in this part of a two-part article are fuel cells and thermoelectric converters. Thermionic converters, solar cells, magnetohydrodynamic generators, etc. will be discussed in Part 2.	Aug	54
Resistors		
Derating—Its Meaning and Limitations, J. R. Isken ..... Critical review of current derating practices and philosophies. Practical, safe derating cannot be achieved in a design without careful consideration and evaluation of the component's capabilities. Suggestions are offered for obtaining more realistic and useful results. Examples are cited from *resistor* derating practice.	Jun	80
The Weighted Resistor Decoder: An Error Analysis, N. Aron and R. A. Goundry ..... The relation between accuracy of conversion and resistor tolerance is analytically determined for a binary-weighted resistor network used as a digital-to-analog converter (decoder).	Apr	154
Semiconductor Devices		
Thermistor-Resistor Temperature-Sensing Networks, O. Schwelb and G. C. Temes ..... A procedure for the design of networks (either four-pole or two-pole) consisting only of resistors and a thermistor for use in temperature-sensing applications. The thermistor may have either a negative or a positive temperature coefficient. Extensive tables give design parameters.	Nov	71
Solid-State Devices in Appliance Control—A Projection, J. D. Harnden, Jr. ..... Possible applications of the newer semiconductor and other devices are considered for performing such functions as switching, timing, sensing and control (plus power conversion). Reliable operation, high efficiency, great power gains and small size of transistors, silicon controlled rectifiers, photoconductors and thermistors provide advantages to the designer willing to take a fresh look on an integrated systems level.	Nov	121
Trends in Semiconductor Devices for Microwave Applications, M. Tenzer ..... A review of the latest developments in transistors, diodes, tunnel diodes, parametric amplifiers, etc. Specific information on the capabilities of various types at microwave frequencies.	Oct	82
Using the Silicon Controlled Rectifier for Protection, F. W. Gutzwiller ..... Consideration is given to the use of the silicon controlled rectifier as a protective element against overcurrents and overvoltages. Several types of circuits are described: gate blocking, electronic crowbarring, and current-limiting circuit breaker.	Oct	130
Transient Protection for High-Frequency Transistors, W. D. Roehr ..... Three common types of transistor circuits (video and r-f amplifiers, mutually coupled amplifiers, etc.) are analyzed with a view to discovering what causes transistor failures due to switching transients. Proper means of correction are given.	Sep	82
Semiconductor Failure Analysis Using Characteristic Curves, R. A. Holladay ..... Four basic types of semiconductor failures are discussed: stress, voltage breakdown, degradation, and dissipation. The effects that each of them has in changing the shape and appearance of the characteristic curves are described and illustrated with specific examples.	Aug	76
Tunnel-Diode Capacitance Measurements, E. Adler and R. C. Wonson ..... The measurement of the capitance of a tunnel diode is made difficult by the occurrence of spurious oscillations and by the fact that the capacitance is not directly accessible at the diode terminals. Specific suggestions, including circuits and instrumentation, are given to help solve this testing problem.	Aug	118
Firing Circuits for Silicon Controlled Rectifiers, W. J. Brown ..... Various types of firing circuits are reviewed: unijunction transistors, magnetic amplifiers, phase-shift networks. Special emphasis and design details are given for Silicontrol, which is a combination of a magnetic circuit and a phase-shift circuit.	Jul	79
Semiconductor Rectifier Characteristics, E. J. Diebold ..... Definitions of terms and description of forward and reverse characteristics. Design of circuits to be used in testing cells, including load tests. Discussion of possible misleading details to be ware of in making tests.	Jun	72
A Procedure for the Design of Transistor Bias Networks, G. E. Platzer, Jr. ..... By using a few simple equations and two easily obtained graphs, the values of biasing resistors which will provide suitable temperature stability of the operating point are readily calculated. Methods used in arriving at the equations for the networks discussed can be used for other bias schemes as well.	Apr	97
Semiconductor Electronics 6—Non-Linear and Switching Operation, A. A. Sorensen ..... The final article in a six-part series. The characteristics of the transistor are developed for switching operation. Approach is based on the three regions of operation: cutoff, linear, and saturation. Discussion of dynamic characteristics centers on switching times and power consumption.	Mar	125
Semiconductor Electronics 5—Transistor Amplifier Design, A. A. Sorensen ..... The first step in designing a transformer is to determine the load line and operating point. Various other factors (small-signal parameter variations and maximum ratings) must also be taken into account. This fifth article in the series is of a practical application nature with complete information on the actual design of various amplifier types.	Feb	93

Subject Classification | Month | Page

Semiconductor Electronics 4—Transistor Network Analysis, A. A. Sorensen ..... Jan 105
General four-terminal networks are analyzed in terms of the various possible parameters. The same techniques are then applied to transistor circuits. Properties of common-base, common-emitter, and common-collector connected transistors are developed. (The fourth in a six-part series.)

A Technique for Measuring High-Frequency Transistor Characteristics, R. Fekete..... Jan 126
Test equipment to measure high-frequency small-signal transistor parameters, such as current gain, has been developed. By using suitable adaptors, other parameters and other two- or four-terminal devices can be measured. Essentially a complex voltage-ratio meter that measures the absolute value of two voltages or their ratio, and the phase angle between them, the device uses low signal levels at frequencies below 50 mc.

Thermoelectric Devices

Thermoelectric Refrigeration and its Application, R. S. Lackey and W. L. Wright..... Jan 68
A practical approach to the theory of refrigeration using thermoelectric effects, with actual examples to illustrate application of the various principles to the design of a device.

Transducers

Small Encoder Offers Fine Angular Resolution, W. R. Knapp, Jr..... Feb 140
Angle encoder provides a total count of 360,000 with one revolution of the input shaft, thus providing readings to thousandths of a degree. A description of the electronic "vernier" system used to provide fine angular resolution is given.

Wire and Cable

Stability of Epoxy-Encapsulated Magnet-Wire Systems—An Analysis of Compatibility Factors, A. E. Javitz..... Mar 82
The reliability of epoxy-resin encapsulated magnet-wire systems is analyzed in terms of compatibility between the encapsulating compounds and the magnet-wire insulation. The results of investigations on various combinations of resin compounds and magnet-wire film insulation are given in terms of various operating parameters, particularly thermal stability. A number of specific and general design conclusions are drawn from the data given.

COMPONENTS, MECHANICAL/STRUCTURAL

Drive Elements

Automatic Switching Control with Electric Clutches and Brakes, P. Block and D. Hennings ..... Dec 84
Torque-slip characteristics, average torque curves, thermal rating and flux build-up and decay times are considered for direct-acting, friction-disk electromagnetic clutches and brakes for mechanical power-switching functions. Control devices are reviewed and basic control circuits illustrated, including methods of providing overexcitation and underexcitation. General-purpose transistor control.

Gears

Factors Contributing to Backlash in Gear Trains, R. J. Benson..... Jul 66
Factors that comprise the total backlash in fine-pitch spur gear trains are considered, along with detailed calculations. Included are effects of changes in center distance, method of calling out tolerances, pressure angle, and total composite error in gears; thinning, deflection and wear of teeth; radial play in bearings and differential expansion between housing and gears; also shaft twist.

Subject Classification | Month | Page

Springs

Copper-Base Alloy Spring Materials, A. E. Moredock ..... Sep 76
The properties and limitations of copper-base alloys used in spring design are studied. Choice of standard and new materials is evaluated for service conditions and design requirements. Included is a specially prepared table of properties, specifications and comparative costs of materials.

Spring Design for Electronic Equipment, J. P. Davis..... Apr 121
Typical compression, extension, torsion and flat springs are considered, with examples worked out by established equations and tabular data on materials properties. Conservative stress values are used in line with military reliability norms.

COMPUTING MACHINES

Applications (for design, see Systems, Computer-type Subsystems)

Techniques of Analog Simulation, A. W. Langill, Jr..... Dec 70
A review of the theory and practice involved in the programming of large-scale electronic analog computers. Basic components are described and their use in simulating both linear and non-linear systems is discussed with examples.

Control-System Analysis by Analog Simulation, W. E. Sollecito..... May 131
Presents fundamentals of analog computation and its use in simulating feedback control systems. Simulation is used in the basic design procedure to eliminate costly experimentation with hardware.

Designing Electronic Transformers on a Digital Computer, R. Lee..... May 147
To demonstrate the iterative procedures used to optimize the design of small electronic transformers within limits of overall performance, the computer programming for a single-secondary transformer in the range of 4 to 3230 va core rating is detailed. Modifications of the program for designing rectifier-plate transformers and linear inductors are also described.

The Forum: Computing Machines in Control Systems. 1. Principles of Data Processing in Numerical Control of Machine Tools, J. L. McKelvie..... Mar 135
Automatic control by orders which are introduced in the form of numbers has become an important concept. The basic principles of numerical control systems used by the metalworking industry are presented.

The Forum: Computing Machines in Control Systems. 2. Panel Discussion—Machine-Tool Control, A. R. Robinson, A. M. Hilton, F. J. Oliver, J. L. McKelvie, B. Harris, S. M. Matsa and V. Rogers..... Mar 145
The design of a numerical machine-tool control system requires careful integration of ideas from several technological areas. Positioning systems involving little data processing at the machine and contouring systems involving complex data processing are discussed. A panel of experts weighs the advantages and disadvantages of different design approaches and discusses the role of computing machines.

DESIGN CONSIDERATIONS

Cost Factors

Dollar Trade-Offs in Systems Design Involve Total Engineering, D. B. Ehrenpreis ..... May 78
A systematic method is outlined for trading off eleven design and development system-parameters against each other in terms of "equivalent dollar" penalties and values. The technique described uses value equations and dollar trade-off

(DTO) coefficients in developing a system, design concept, end product or subassembly for maximum cost effectiveness. Examples are given in the design of electronic structural modules.

Environmental Effects

Summary of Nuclear Radiation Effects on Electronic Components and Systems, J. E. Drennan and E. N. Wyler ..... Mar 132
A "state of the art" summary of current knowledge of the effects of different types of nuclear radiation on components and systems. Reports cover electron tubes, resistors, capacitors, relays, switches, terminals, transformers, transistors, semiconductor diodes and electronic systems. A supporting bibliography is also given.

Environmental Evaluation of Magnetic Materials, D. I. Gordon ..... Jan 118
Results of studies completed by U. S. Naval Ordnance Laboratory and others in the development and utilization of magnetic materials performance in extreme environments. Included are both soft core materials and hard permanent-magnet materials. Environmental performances are evaluated under conditions of 500 C (and above) temperatures, nuclear radiation up to $\sim 10^{17}$ fast neutrons/cm² and nuclear pulse radiation up to 10^{15} fast neutrons/cm².

Human Factors

Human-Factors Engineering Design Standards, M. A. Tolcott, A. N. Chambers, P. Preusser and Staff, Dunlap and Associates, Inc. Aug 103
Basic considerations and necessary procedures for the development of human-factors engineering standards and specifications are discussed. Illustrations of design "guidelines" and "checklists" are drawn from work done in connection with systems requirement for equipment used in the Polaris missile submarine. Search and evaluation of system components from the human-factors viewpoint are essential in such work.

Engineering Psychology and Human Factors in Design, Members of the Research Staff, Dunlap and Associates, Inc. and A. E. Javitz ..... May 107
Engineering psychology is considered as a primary experimental research arm of human-factors engineering. Fundamental areas of the subject are discussed with relevance to equipment and systems-design parameters. The basic concept is that of the man-machine-environment interactions and the ultimate reliability of system performance.

Radio Noise and Interference

Electrical Noise Control, J. E. Curran ..... Dec 117
Some specific suggestions for designers of complex, high-speed, solid-state systems with regard to the control or elimination of unwanted electrical noise.

Quiet Wiring, W. Morton ..... Mar 78
An explanation of the causes of noise due to improper wiring procedures or natural effects which cannot be avoided. Ways of reducing noise in each case are given.

Reliability

Solid-State Devices in Appliance Control—A Projection, J. D. Harnden, Jr. ..... Nov 121
Possible applications of the newer semiconductor and other devices are considered for performing such functions as switching, timing, sensing and control (plus power conversion). Reliable operation, high efficiency, great power gains and small size of transistors, silicon controlled rectifiers, photoconductors and thermistors provide advantages to the designer willing to take a fresh look on an integrated systems level.

Improving Analog-Circuit Reliability with Redundancy Techniques, A. A. Sorensen ..... Oct 66
A summary of the results obtained by the application of redundancy to various types of analog circuits and devices, such as a-c and d-c amplifiers. Both passive and active (switching) redundancy are applied and comparisons are made between several possible techniques. Formulas are derived which enable the designer to ascertain the actual reliability improvements to be expected.

Semiconductor Failure Analysis Using Characteristic Curves, R. A. Holladay ..... Aug 76
Four basic types of semiconductor failures are discussed: stress, voltage breakdown, degradation, and dissipation. The effects that each of them has in changing the shape and appearance of the characteristic curves are described and illustrated with specific examples.

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Derating—Its Meaning and Limitations, J. R. Isken ..... Jun 80
Critical review of current derating practices and philosophies. Practical, safe derating cannot be achieved in a design without careful consideration and evaluation of the component's capabilities. Suggestions are offered for obtaining more realistic and useful results. Examples are cited from resistor derating practice.

Dollar Trade-Offs in Systems Design Involve Total Engineering, D. B. Ehrenpreis ..... May 78
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The Word is RELIABILITY, Staff Report ..... May 94
Engineers and others professionally involved in the various activities in which the principles of "reliability" are important were asked for comments on three questions. The propositions were selected to demonstrate the wide spectrum of interests spanned by "reliability," and the consequent variety of opinion. Not a panel discussion or symposium, the article stresses informal personal views.

Analyzing Failure Rates in Electronic Components, G. W. A. Dummer ..... Feb 89
Variables in component manufacture and application impose difficulties on accurate *statistical analysis of reliability*. Typical faults caused by such variables are discussed. Failure data for specific equipments under given operating and environmental conditions are presented.

Strength and Weight Factors

Dollar Trade-Offs in Systems Design Involve Total Engineering, D. B. Ehrenpreis ..... May 78
A systematic method is outlined for trading off eleven design and development system-parameters against each other in terms of "equivalent dollar" penalties and values. The technique described uses value equations and dollar trade-off (DTO) coefficients in developing a system, design concept, end product or subassembly for maximum cost effectiveness. Examples are given in the design of electronic structural modules.

Thermal Design Factors

Cryogenics: Selection Data for Structural Materials, J. F. Watson, J. L. Christian and J. Hertz ..... Nov 76
The behavior of metals and nonmetals under various combinations of cryogenic and other environments is discussed and analyzed on the

basis of a special study related to aerospace and missile applications. Materials examined include stainless steel, aluminum, titanium and cobalt-nickel alloys, plastics laminates, adhesives and thermal insulation. (Concluding article of a 2-part series.)

Thermal Design Considerations in Thin-Film Microelectronics, J. R. Baum ..... Jul 92
Analysis of problems associated with adequate thermal design in thin-film devices. Problem is examined with two considerations in mind: thermal characteristics of individual circuit elements and the modes of heat transfer and temperature gradients in substrate assembly concepts.

Thermally Conductive Cast-Resin Compounds for Heat Dissipation, C. A. Harper ..... Apr 148
Cast-resin embedments for electronic packaging can provide satisfactory heat dissipation by utilizing resin compounds of sufficiently high thermal conductivity. This article describes the effect of various compound fillers that improve conductivity and discusses the nature and significance of filler properties and characteristics. Thermal conductivity data are applied to specific design problems.

Thermoelectric Refrigeration and its Application, R. S. Lackey and W. L. Wright ..... Jan 68
A practical approach to the theory of refrigeration using thermoelectric effects, with actual examples to illustrate application of the various principles to the design of a device.

Instrument Motor Temperature-Rise Factors, R. Matthews ..... Jan 132
The influence of electrical input, duty cycle and method of mounting on instrument motor temperature and life are depicted. Tests of a typical motor are used to demonstrate the motor application advice.

HEAT FLOW

Transient Heat Flow, R. P. Benedict ..... Dec 93
Graphical, numerical and electrical network analog methods of stepwise solution to the basic heat-conduction equations are described and compared. Problems and analog circuit data are included.

Extended Surfaces for Heat Transfer: 5—Spines, A. D. Kraus ..... Jul 107
The last of the five-part series of articles on extended surface thermal analysis explores the spine or pin shape. Various spine profiles are studied and analyzed, and their efficiencies compared.

Extended Surfaces for Heat Transfer: 4—Optimum Shapes for Longitudinal Fins. Radial Fins of Hyperbolic Profile, A. D. Kraus ... Jun 111
The various primary profile forms for longitudinal fins are examined, and analytical methods of design for optimal heat-transfer and material use are developed. The hyperbolic-profile radial fin is also explored, and compared with the rectangular shape.

Extended Surfaces for Heat Transfer: 3—Longitudinal Fins of Non-Rectangular Profile, A. D. Kraus ..... Apr 129
The analysis of the longitudinal fin of rectangular profile presented in Part 1 of this series was fundamental because of constant cross-sectional areas. The study of the rectangular fin is now continued for the more complex considerations involved in non-rectangular shapes, illustrated by triangular, trapezoidal and parabolic profiles.

Extended Surfaces for Heat Transfer: 2—Radial Fins of Rectangular Profile, A. D. Kraus ... Mar 94
Design methods for radial fins are outlined. Fins of this general shape involve more variables than the longitudinal fins covered in the first article of this series, but certain simplifications permit straightforward analysis.

Extended Surfaces for Heat Transfer: 1—Longitudinal Fins of Rectangular Profile, A. D. Kraus ..... Feb 72
The first of a five-part series of articles deriving and demonstrating design methods for extended-surface heat transfer. Longitudinal fins of rectangular profile are fundamental and are used for the initial basic development of the analysis.

INSTRUMENTS AND TEST EQUIPMENT

Design (for application, see Test and Measurement)

The Thermistor Bridge, D. S. Saulson ..... Sep 73
An analysis of the thermistor bridge as applied to temperature-control systems. The Thevenin equivalent circuit of the thermistor bridge enables facile determination of output current and the condition for maximum gain.

Measuring Functional Accuracy of Hall-Effect Generators, S. Harac ..... Sep 134
Method and equipment used on solid-state resolvers to check the extent of departure, at any point of rotation, of the Hall output from the true sine value. Description of the measuring instrument.

MATERIALS, ELECTRICAL/ELECTRONIC

Aerospace Electronic Materials—Applications/Environments/Effects, E. G. Linden ..... Dec 125
A review of studies of materials and their reactions to outerspace conditions. The problems of materials exposed externally and internally are approached from the standpoints of vacuum, temperature control, ultraviolet light, Van Allen belt radiations, lubrication of bearing surfaces, and plastics volatility. An extensive bibliography is integrated with this review.

The Design Analysis of Materials, A. E. Javitz and H. E. Barkan ..... May 136
The intrinsic design value of materials can be determined only by an analysis of a number of interrelated and interdependent factors, among them: inherent properties, effect of fabrication processing, effect of form and configuration, influence of research, influence of test methods, and cost relationships. Principles of design analysis are examined and examples of application are given.

Conductor Materials

Electrical Insulation System for 350 C Wafer-Coil Transformers, B. L. Sawyer ..... Feb 131
Results of a Navy Bureau of Ships-sponsored investigation to develop techniques and materials for design of wafer-coil type of audio, pulse and filament transformers for 350 C service. Report presents comparative performance data on various materials. End design uses inorganic interlayer insulation, *aluminum foil conductors*, and aluminum oxide powder for potting purposes.

Electrical Insulation and Dielectrics

Flame Resistance of Plastics—A Key "Design-for-Safety" Factor, L. N. Chellis ..... Dec 77
The steadily increasing use of plastics materials as mechanical and dielectric elements in a wide variety of applications has focused serious attention on the flame-resistance characteristics of these materials. This article reviews various flammability tests (both for materials and finished components), cites qualitative and quantitative test data, and reproduces selected industry standards.

Mechanical-Property Considerations in Epoxy Insulation, J. Delmonte ..... Nov 127
Though electrical properties of epoxy insulation are obviously important, the functional mechanical properties may be equally or more important. The need for good mechanical properties, as against over-emphasis on electrical properties,

is stressed. The various mechanical properties of representative epoxies are discussed in detail.

Electrical Breakdown in Solids and Liquids, A. H. Sharbaugh and J. C. Devins ..... Oct 97
The basic concepts of electrical breakdown, previously examined by the authors in relation to gases (*cf* February 1961 issue of ELECTRO-TECHNOLOGY), are now extended to considerations of breakdown phenomena in solids and liquids. Experimental studies are discussed and various theories of breakdown are elucidated, in some instances with the use of mathematical examples.

Frequency Dependence of Electric Strength . . . a Design Consideration Analysis, L. J. Frisco ..... Aug 110
Frequency dependence of electric strength at frequencies up to 100 mc is an important design factor in the application of electrical insulating materials. This article summarizes the results of an intensive investigation at The Johns Hopkins University Dielectrics Laboratory for the purpose of developing appropriate data. Test values are given for 31 different classes of materials, test methods are described, and the results are discussed in design terms.

Combined Time-Temperature Data for Electrical/Electronic Laminates, Staff Report ..... Jul 116
Results of NEMA-sponsored investigation of paper and cotton-base phenolic laminates, glass-base melamine and silicone laminates, also glass-mat polyester and glass-cloth/epoxy types under various time exposures—less than 1 hr and up to 100 hr—at temperatures of 130 C, 220 C and 260 C.

Effects of Corona on Vinyl Electrical Data, M. Olyphant, Jr. ..... Jun 123
Despite increasing use of vinyl insulation under corona conditions, there is lack of meaningful evaluation data on related performance. This report summarizes the results of a research program intended to rectify this situation. Data are given on the relation of various physical and electrical properties of vinyl tape to corona resistance, also the effect of various test and atmospheric conditions.

Thermally Conductive Cast-Resin Compounds for Heat Dissipation, C. A. Harper ..... Apr 148
Cast-resin embedments for electronic packaging can provide satisfactory heat dissipation by utilizing resin compounds of sufficiently high thermal conductivity. This article describes the effect of various compound fillers that improve conductivity and discusses the nature and significance of filler properties and characteristics. Thermal conductivity data are applied to specific design problems.

Stability of Epoxy-Encapsulated Magnet-Wire Systems—An Analysis of Compatibility Factors, A. E. Javitz ..... Mar 82
The reliability of epoxy-resin encapsulated magnet-wire systems is analyzed in terms of compatibility between the encapsulating compounds and the magnet-wire insulation. The results of investigations on various combinations of resin compounds and magnet-wire film insulation are given in terms of various operating parameters, particularly thermal stability. A number of specific and general design conclusions are drawn from the data given.

The Fundamental Nature of Electrical Breakdown, J. C. Devins and A. H. Sharbaugh ..... Feb 103
An exposition of the various aspects of the subject for the systems and design engineer, including classical concepts of the mechanisms of breakdown, the effects of time lags, the influence of variables, and the relationships between breakdown and the nature of the dielectric (primarily electron behavior and molecular structure). A minimum of mathematics is employed, with physical illustrations and analogies being used as much as possible.

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Thermal Classification of Pressure-Sensitive Adhesive Electrical Tapes, R. E. Hudrlik and W. M. Hanson ..... Jan 113
Growing applications for pressure-sensitive electrical tapes as permanent elements in insulation systems lead to a detailed investigation of their temperature aging behavior, so that the tapes can be fitted into temperature classes with predictable service life. Several tapes (including some newer types) were subjected to physical and electrical tests, among them a dynamic flexing test. Results are given and analyzed.

Magnetic Materials

Effects of Temperature on Magnetic Properties of Cobalt-Iron Alloys, J. J. Clark and J. F. Fritz ..... Oct 93
A study of normal magnetization curves, coercive forces, residual induction, and total core loss at different inductions for three cobalt-iron alloys in the −60 to +500 C temperature range. Results of temperature cycling are presented in the form of typical curves.

Tests Confirm Merits of Non-Silicon Lamination Steel, S. S. Wolff ..... Jul 84
The use of controlled and properly annealed low-carbon steel for motor laminations is discussed. Results of tests are presented, comparing performance of motors using the carbon steel with those employing the more expensive silicon-bearing materials.

Advances in Magnetism and Magnetic Materials, H. E. Barkan ..... Feb 80
Selected papers presented at the Sixth Annual Conference on Magnetism and Magnetic Materials are reviewed and interpreted for the design engineer. Included are theoretical aspects of the conference, and sections reviewing new aspects of thin metallic films, oxides, high coercive materials, metals and alloys, and soft magnetic materials. Charts and graphs illustrate many points brought out in the text.

Environmental Evaluation of Magnetic Materials, D. I. Gordon ..... Jan 118
Results of studies completed by U. S. Naval Ordnance Laboratory and others in the development and utilization of magnetic materials performance in extreme environments. Included are both soft core materials and hard permanent-magnet materials. Environmental performances are evaluated under conditions of 500 C (and above) temperatures, nuclear radiation up to $\sim 10^{17}$ fast neutrons/cm^2 and nuclear pulse radiation up to 10^{15} fast neutrons/cm^2.

Semiconductor Materials

Organic Semiconductors—A Research Report, H. A. Pohl ..... May 85
A factual review of basic research work in the field of organic semiconductor materials and their potentialities in practical electronic devices. Conductivity data for certain experimental compounds are included.

MATERIALS, MECHANICAL/STRUCTURAL

Aerospace Electronic Materials—Applications/Environments/Effects, E. G. Linden ..... Dec 125
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Metals

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Copper-Base Alloy Spring Material, A. E. Moredock ..... Sep 76
The properties and limitations of copper-base alloys used in spring design are studied. Choice of standard and new materials is evaluated for service conditions and design requirements. Included is a specially prepared table of properties, specifications and comparative costs of materials.

Wear of Materials—Impact on Design Failure, H. E. Barkan ..... Jul 95
A study of the basic concepts of wear of materials, based on the results obtained from the observation of *wear in metals*. Descriptions of the phenomenon of wear as applied to design engineering are discussed. Wear and its minimization are examined and reported. The text is supported by tables and an extensive bibliography.

Applications of Tantalum in Electronic Design, D. J. Maykuth ..... Jun 129
Current and proposed development design uses for tantalum in electronic equipment are explored. The effects of properties and fabrication on design parameters are investigated and conclusions as to the feasibility for certain designs are given. The text is supported by charts and graphs, and documented by cited references.

Solders—Their Function in Designing Aluminum Parts, G. O. Hoglund, F. R. Collins and H. E. Barkan ..... Apr 101
A study of low-cost, low-temperature joining by soldering of aluminum structural and electrical components assemblies. The feasibility of the soldering process, design parameters and considerations, and performance of soldered joints are evaluated. A short description of materials and methods is included. The advantages and disadvantages of soldering and its various methods are discussed.

Nonmetallic Materials

Flame Resistance of Plastics—A Key "Design-for-Safety" Factor, L. N. Chellis ..... Dec 77
The steadily increasing use of plastics materials as mechanical and dielectric elements in a wide variety of applications has focused serious attention on the flame-resistance characteristics of these materials. This article reviews various flammability tests (both for materials and finished components), cites qualitative and quantitative test data, and reproduces selected industry standards.

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Protective Coatings

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Though electrical properties of epoxy insulation are obviously important, the functional mechanical properties may be equally or more important. The need for good mechanical properties, as against over-emphasis on electrical properties, is stressed. The various mechanical properties of representative epoxies are discussed in detail.

Thermal and Acoustical Insulation

Electrical Analog for Vibration-Damping Measurements, W. Hand ..... Nov 117
When evaluating the damping characteristics of a vibration-deadening material, the accuracy of the electrical measuring circuits must be checked. Substituting an electrical analog circuit with known parameters for the test specimen provides a simple checking method. Such an electrical analog is derived and its use explained in an example.

MOTORS

All Classifications

Tests Confirm Merits of Non-Silicon Lamination Steel, S. S. Wolff ..... Jul 84
The use of controlled and properly annealed low-carbon steel for *motor laminations* is discussed. Results of tests are presented, comparing performance of motors using the carbon steel with those employing the more expensive silicon-bearing materials.

Fractional-Horsepower

The Permanent-Field Synchronous Motor, F. W. Merrill ..... Dec 113
The operating principles and characteristics of the permanent-field synchronous motor are described, and compared with reluctance and hysteresis motors. For small-motor design especially, the significance of recent magnetic materials advances are discussed.

New High-Performance Designs for Small Synchronous Motors, A. Bekey ..... Nov 85
The operating principles and particular advantages of three basically new synchronous motor designs are related. Included is a discussion of the theoretical and practical advantages of these developments over traditional forms of the small motor.

Shading Coils Energized for Motor Control, C. Kasparian ..... Oct 120
Continuous control of a small reversing drive uses a shaded-pole motor with energized coils in place of the customary short-circuited single turns. Circuit principles and application are described.

Instrument

Selecting Balancing Motors for Measuring Systems, E. Moraski ..... Aug 80
Each major component of a typical null-balance measuring system is described and related to system design and performance. Special emphasis is placed on balancing-motor characteristics.

Instrument Motor Temperature-Rise Factors, R. Matthews ..... Jan 132
The influence of electrical input, duty cycle and method of mounting on instrument motor temperature and life are depicted. Tests on a typical motor are used to demonstrate the motor application advice.

Integral-Horsepower

Saturable Reactor Control of D-C Motors, H. R. Weed and S. P. Jackson ..... Jul 103
A method of analysis is developed which derives describing equations and characteristic curves. The analysis is generally applicable to series

saturable reactors used to control any load which is inductive and contains a back-emf element.

PRODUCTION AND ASSEMBLY TECHNIQUES

Soldering and Solderless Techniques

Solders—Their Function in Designing Aluminum Parts, G. O. Hoglund, F. R. Collins and H. E. Barkan ..... Apr 101
A study of low-cost, low-temperature joining by soldering of aluminum structural and electrical components assemblies. The feasibility of the soldering process, design parameters and considerations, and performance of soldered joints are evaluated. A short description of materials and methods is included. The advantages and disadvantages of soldering and its various methods are discussed.

SPECIFICATIONS AND STANDARDS

A Complementary Symmetry Emitter-Follower, Preferred Circuits Program, U.S.N.A.D.C. Dec 132
Complete design details for a very important circuit from the U. S. Navy's *Handbook of Preferred Circuits*.

Transformer Specification for Reliable Electronic Equipment, D. Epstein..... Oct 76
Specification MIL-T-27A is interpreted and the need for additional information detailed with respect to environmental conditions, electrical requirements and mechanical considerations to aid the systems or subsystems designer in getting his requirements met by the transformer manufacturer.

Relay Designers and Users Meet, M. M. Meyers Jul 74
A summary report on the Ninth National Conference on Electromagnetic Relays, held April 24–27, 1961 at Oklahoma State University. Nine technical papers are reviewed. Covered are relay contact failure, special telephone-relay contacts, contact spring for reduced chatter in high-speed relays, high-speed relay operation with minimal power, dry-reed relay logic device, r-f interference suppression, and test and measurement.

SYSTEMS

Communication

A Complementary Symmetry Emitter-Follower, Preferred Circuits Program, U.S.N.A.D.C. Dec 132
Complete design details for a very important circuit from the U. S. Navy's *Handbook of Preferred Circuits*.

Global Communications—State of the Art, R. Kestenbaum ..... Nov 62
Review of present global communications facilities, including high-frequency and microwave communications, ionospheric and tropospheric scatter, and submarine cables. Discussion of the inadequacies posed by existing systems. The introduction of passive and active satellite systems as solution to future world-wide communication needs. Project Echo. Detailed description of communication problems peculiar to earth-space-earth transmission.

Computer-Type Subsystems

Digital Matchers, R. E. Leslie and F. Crawford Nov 113
The theory of operation of digital matchers, or coincidence indicators, is given. Various ways of designing the circuits are discussed, with special emphasis on the use of transistor-resistor logic.

Improving Analog-Circuit Reliability with Redundancy Techniques, A. A. Sorensen ..... Oct 66
A summary of the results obtained by the application of redundancy to various types of analog circuits and devices, such as a-c and d-c amplifiers. Both passive and active (switching) redundancy are applied and comparisons are made between several possible techniques. Formulas are derived which enable the designer to ascertain the actual reliability improvements to be expected.

Digital Logic Modules, J. R. Riggs ..... Sep 64
A survey of the various types of modules that are available for performing the basic logic functions: diode gates, transistor-diode logic, transistor-resistor logic, resistor-capacitor transistor logic, and direct-coupled transistor logic. Examples give electrical and physical characteristics of units available from 26 manufacturers.

Design of Reversible Magnetic Shift Registers, R. Yii and L. Mintz..... Aug 66
By combining transistors with magnetic cores, fast, economical, reversible shift registers can be obtained. The design of the circuits is explained in detail, including input pulse requirements and determination of switching speeds.

Simplifying Switching Circuits with Boolean Algebra, G. A. Maley ..... May 101
Using basic Boolean algebra principles, some special techniques are presented for simplifying circuit complexity and eliminating unnecessary hardware. Deals specifically with the use of a transistor NAND as a universal connective block.

Superconductive Circuits for Computing Machines, V. L. Newhouse..... Apr 78
Gain and time constants of wire-wound and film-type cryotrons are compared. Cross-film types function as logic circuit elements. Because the cost and bulk of deposited crossed-film cryotrons is considerably below that of transistors and they dissipate only about 1/1000 that of transistor energy, their use in extremely compact digital computer systems of high speed is foreseen.

The Weighted Resistor Decoder: An Error Analysis, N. Aron and R. A. Goundry ..... Apr 154
The relation between accuracy of conversion and resistor tolerance is analytically determined for a binary-weighted resistor network used as a digital-to-analog converter (decoder).

A Proportional Logic System, W. H. Price, II .. Feb 138
Logic functions of digital techniques and the proportional function of analog systems are combined in a process-control system to correct four conditions of material in-feed misalignment. Since normal logic elements are not proportional, a proportional coincidence gate was devised, the design of which is described.

Control Case Histories

Shading Coils Energized for Motor Control, C. Kasparian ..... Oct 120
Continuous control of a small reversing drive uses a shaded-pole motor with energized coils in place of the customary short-circuited single turns. Circuit principles and application are described.

Control Systems, General

Automatic Switching Control with Electric Clutches and Brakes, P. Block and D. Hennings ..... Dec 84
Torque-slip characteristics, average torque curves, thermal rating and flux build-up and decay times are considered for direct-acting, friction-disk electromagnetic clutches and brakes for mechanical power-switching functions. Control devices are reviewed and basic control circuits illustrated, including methods of providing overexcitation and underexcitation. General-purpose transistor control.

Universal-Motor Speed Controls, F. W. Gutzwiller Dec 138
Various circuit designs for using the silicon controlled rectifier to vary the speed of the universal, series motor.

Transient Protection for High-Frequency Transistors, W. D. Roehr ..... Sep 82
Three common types of transistor circuits (video and r-f amplifiers mutually coupled amplifiers, etc.) are analyzed with a view to discovering

Subject Classification	Month	Page
what causes transistor failures due to *switching transients*. Proper means of correction are given.		
Firing Circuits for Silicon Controlled Rectifiers, W. J. Brown ..... Various types of firing circuits are reviewed: unijunction transistors, magnetic amplifiers, phase-shift networks. Special emphasis and design details are given for Silicontrol, which is a combination of a magnetic circuit and a phase-shift circuit.	Jul	79
Simplifying Switching Circuits with Boolean Algebra, G. A. Maley ..... Using basic Boolean algebra principles, some special techniques are presented for simplifying circuit complexity and eliminating unnecessary hardware. Deals specifically with the use of a transistor NAND as a universal connective block.	May	101
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Control-System Analysis by Analog Simulation, W. E. Sollecito ..... Presents fundamentals of analog computation and its use in simulating feedback control systems. Simulation is used in the basic design procedure to eliminate costly experimentation with hardware.	May	131
The Forum: Computing Machines in Control Systems. 1. Principles of Data Processing in Numerical Control of Machine Tools, J. L. McKelvie ..... Automatic control by orders which are introduced in the form of numbers has become an important concept. The basic principles of numerical control systems used by the metalworking industry are presented.	Mar	135
The Forum: Computing Machines in Control Systems. 2. Panel Discussion—Machine-Tool Control, A. R. Robinson, A. M. Hilton, F. J. Oliver, J. L. McKelvie, B. Harris, S. M. Matsa and V. Rogers ..... The design of a numerical machine-tool control system requires careful integration of ideas from several technological areas. Positioning systems involving little data processing at the machine and contouring systems involving complex data processing are discussed. A panel of experts weighs the advantages and disadvantages of different design approaches and discusses the role of computing machines.	Mar	145

Mechanical

Factors Contributing to Backlash in Gear Trains, R. J. Benson ..... Factors that comprise the total backlash in fine-pitch spur gear trains are considered, along with detailed calculations. Included are effects of changes in center distance, method of calling out tolerances, pressure angle, and total composite error in gears; thinning, deflection and wear of teeth; radial play in bearings and differential expansion between housing and gears; also shaft twist.	Jul	66

Power (Drives)

Automatic Switching Control with Electric Clutches and Brakes, P. Block and D. Hennings ..... Torque-slip characteristics, average torque curves, thermal rating and flux build-up and decay times are considered for direct-acting, friction-disk electromagnetic clutches and brakes for mechanical *power-switching functions*. Control devices are reviewed and basic control circuits illustrated, including methods of providing overexcitation and underexcitation. General-purpose transistor control.	Dec	84
Unconventional Power Sources—2, E. Randall... Theory, electrical characteristics, and state of the art of thermionic converters, solar cells, magnetohydrodynamics, photoemissive generators, ferroelectric converters, and devices utilizing the Austin effect. (Covered in Part 1 were fuel cells and thermoelectric devices.)	Sep	85
Unconventional Power Sources—1, E. Randall... A survey of the various types of "exotic" power sources that are being developed particularly for use in space vehicles. Special emphasis on electrical characteristics, efficiencies, power-to-weight ratios, etc. Covered in this part of a two-part article are fuel cells and thermoelectric converters. Thermionic converters, solar cells, magnetohydrodynamic generators, etc. will be discussed in Part 2.	Aug	54
Precise Variable-Speed, Constant-Frequency Alternator, W. R. Appleman ..... A-C power generator system is described in which a three-phase a-c current is applied to a distributed winding of the alternator rotor of such frequency as to make up the difference between the speed-dependent frequency and a reference frequency. Frequency comparison is obtained through a tachometer generator.	Aug	63
Drive Developments Stressed at Machine Tool Forum, Staff Report ..... Digest of selected papers presented at the 25th Westinghouse Machine Tool Forum. New drives and modifications of others are described, along with user experience with them. Small relays are evaluated and systems implications analyzed.	Jun	119
Variable Speed Control Systems, J. Ben Uri..... Each of the basic forms of electrical drive has inherent advantages and limitations. Simple machines may well serve those applications which do not require the features offered by elaborate systems. Principles of operation of widely used systems are outlined to guide selection.	Mar	91

Recording

Selecting Balancing Motors for Measuring Systems, E. Moraski..... Each major component of a typical *null-balance measuring system* is described and related to system design and performance. Special emphasis is placed on balancing-motor characteristics.	Aug	80

TEST AND MEASUREMENT

Components

Mechanics of Electrical-Contact Failure Caused by Surface Contamination, S. W. Chaikin..... A study of the reasons for failure of contacts in electrical connecting devices, particularly *sealed relays*. Primary interest is in contaminants deposited on the contact surface in the form of base metal and organic contamination. This report details contaminating sources, materials and methods for their control.	Aug	70
Tunnel-Diode Capacitance Measurements, E. Adler and R. C. Wonson ..... The measurement of the capacitance of a tunnel diode is made difficult by the occurrence of spurious oscillations and by the fact that the capacitance is not directly accessible at the diode terminals. Specific suggestions, including circuits and instrumentation, are given to help solve this testing problem.	Aug	118
How to Make *Basic* D-C Measurements—2, J. B. Kelley ..... Of the various fundamental electrical quantities, the closest to an absolute is resistance. For laboratories supporting engineering which depends upon precision electrical measurement, methods are outlined for standardizing basic resistance devices such as Wheatstone, Kelvin and Mueller bridges, shunts and volt boxes.	Apr	138
A Technique for Measuring High-Frequency Transistor Characteristics, R. Fekete..... Test equipment to measure high-frequency	Jan	126

Subject Classification	Month	Page
small-signal transistor parameters, such as current gain, has been developed. By using suitable adaptors, other parameters and other two- or four-terminal devices can be measured. Essentially a complex voltage-ratio meter that measures the absolute value of two voltages or their ratio, and the phase angle between them, the device uses low signal levels at frequencies below 50 mc.		
Instrument Motor Temperature-Rise Factors, R. Matthews ..... The influence of electrical input, duty cycle and method of mounting on instrument motor temperature and life are depicted. *Tests* of a typical motor are used to demonstrate the motor application advice.	Jan	132
Environmental		
Shock/Vibration Testing Gains Speed and Precision 1. The MB Electronics Spectrum Analyzer 2. Calibration of Shock/Vibration Pickups R. Boynton and R. R. Bouche ..... A new instrument for rapid and complete vibration spectrum analysis is described, and the various accepted methods of shock and vibration test pickup calibration are compared.	May	90
General		
Measuring Power Factor of Non-Sinusoidal Waveforms, D. A. Wilhelmson..... A graphical method for finding the approximate relationship between voltage and current is developed for the case in which the waveform is non-sinusoidal or of high frequency.	Nov	126
How to Make *Basic* D-C Measurements—2, J. B. Kelley ..... Of the various fundamental electrical quantities, the closest to an absolute is resistance. For laboratories supporting engineering which depends upon precision electrical measurement, methods are outlined for standardizing basic resistance devices such as Wheatstone, Kelvin and Mueller bridges, shunts and volt boxes.	Apr	138
Materials		
A-C/D-C High-Potential Testing, H. N. Miller.. An introduction to a-c and d-c high-potential testing, its use and guides for proper selection of test equipment for particular applications. Information that may be obtained by high-potential testing is described. A-C and d-c testing are compared, with limitations and advantages of each discussed.	Dec	134
Electrical Analog for Vibration-Damping Measurements, W. Hand ..... When evaluating the damping characteristics of a vibration-deadening material, the accuracy of the electrical measuring circuits must be checked. Substituting an electrical analog circuit with known parameters for the test specimen provides a simple checking method. Such an electrical analog is derived and its use explained in an example.	Nov	117
Mechanics of Electrical-Contact Failure Caused by Surface Contamination, S. W. Chaikin..... A study of the reasons for failure of contacts in electrical connecting devices, particularly sealed relays. Primary interest is in contaminants deposited on the contact surface in the form of base metal and organic contamination. This report details contaminating sources, materials and methods for their control.	Aug	70
Systems		
A-C/D-C High-Potential Testing, H. N. Miller.. An introduction to a-c and d-c high-potential testing, its use and guides for proper selection of test equipment for particular applications. Information that may be obtained by high-potential testing is described. A-C and d-c testing are compared, with limitations and advantages of each discussed.	Dec	134
Measuring Functional Accuracy of Hall-Effect Generators, S. Harac ..... Method and equipment used on *solid-state resolvers* to check the extent of departure, at any point of rotation, of the Hall output from the true sine value. Description of the measuring instrument.	Sep	134

Research Notes

Electron-Momentum Determination with Sound Waves	Jan	12
Current R & D Programs in Electrical Insulation and Dielectric Materials—2	Jan	13
Developments in Optical Masers	Feb	9
Improved Magnetoresistive Device	Feb	11
Electrical Stability of Clay-Loaded Butyl Insulation Compounds	Mar	12
Metal-Bonded Graphite for Electromechanical Applications	Apr	10
Microscopy Techniques for Study of Magnet-Wire Insulation	Apr	11
Electronic Devices in Simulation of Neuron Networks	May	10
Gallium Alloys for Low-Temperature Bonding in Electronic Devices	May	12
Shielding Electronic Circuits against Nuclear Radiation	Jun	12
The Cadmium Sulfide Triode	Jul	12
Ultrahigh-Temperature Plastics with Reactive Diphenyl Oxides	Jul	14
Flexible Ceramic Dielectrics	Aug	13
Effect of Ultrasonics on Natural-Convection Cooling Systems	Sep	12
Niobium Solid-Electrolytic Capacitors	Sep	12
Simulated Inductances	Oct	12
Platinum-Alloy Permanent Magnets	Oct	13
European Literature Abstracts	Nov	12
Barrier-Layer Dielectrics	Nov	13
New Experimental Semiconductor Device	Dec	12
Silicon as a Material for Resistors	Dec	13

Editorials

Wanted: Leap-Frogging Research	Jan	57
No Let-up in Technology	Feb	71
Mathematics—A *Working* Science	Mar	77
The Spectrum of Engineering	Apr	77
Competitive Strength—The Aim of All Design Engineering	May	75
Equity in Government-Contract Patent Policy	Jun	59
Interdisciplinary Engineering—Today and Tomorrow	Jul	65
Energy Flow: the Key to Systems Analysis	Aug	53
Information Storage and Retrieval	Sep	63
Reliability Endangered by Price Cutting	Oct	65
Information Should *Inform*	Nov	61
Short-cuts to Confusion	Dec	69

Design Trends

Page

January 1961

A Technique for Measuring High-Frequency Transistor Characteristics 126
Instrument-Motor Temperature-Rise Factors 132
R-F Level Calibration Console 134

February 1961

A Proportional Logic System 138
Small Encoder Offers Fine Angular Resolution 140
Transistor Choppers 141
Miniature Digital Program Timer 142
Relay Contact Plating Sensing Circuit 144
Multiple-Input Frequency Changer 144
Phase-Shifting Capacitor Serves as Transducer 146
Materials-Applications Notes 148
Pulsed Miniature Counter Gives Indication and Control 150

March 1961

Method for Experimental Study of Relay Stability 156
Magnetic-Amplifier Design for Remote Locations 157
Resistance-Temperature Nomograph 158
Spline-Drive Armature in Rugged Magnetic Clutch and Brake Design 160
Relay Characteristics Amplified 160
Fast-Switching Transistor Operates at Micro-Energy Levels 162
Brush Threading and Selective Action Related to Current Distribution 164
Photoelectric Reader Senses Reflected Light Intensity 166
Heat-Run Slide Rule 168
Shift Registers are Wafer-Thin 170

April 1961

The Weighted Resistor Decoder: An Error Analysis 154
Exceeding Resistor Power Ratings 156
Continuous-Recording Temperature-Measurement by Resistance 158
Thin-Film Memory Planes 162
Materials Evaluation in Printed-Circuit-Board Design 162
Geneva Movement Provides Ten-Turn Rotary Switching 164
Dual-Purpose Digital Computer Is also Differential Analyzer 164
High-Impact Acrylic Replaces Aluminum in Power Timing Light 166

May 1961

Design of a Magnetic Voltage Stabilizer 154
Low-Cost Tachometer Generator 155
Coded Time-Pulse Circuits for Data Correlation 156
Stroboscopic Digital Readout 162
Solid-State X-Y Coordinate Display 164
Voltage Relationships in a Simplified Controlled Three-Phase D-C Rectifier 164

June 1961

Arc Suppression for Contact Protection 134
"Fuzz-Button" Contacts 135
Frequency Counter Has Built-In Memory 136
Vibrating Tube Measures Density 136
Vibration-Testing Machines 138

Page

Practical Aspects in Evaluating Shielded Rooms 138
Bleeder-Resistance Considerations in Single-Phase Rectifiers 144
Microwave Attenuation Measurements Compared 146

July 1961

Precise-Angle Indicator 126
Solid-State Sequence Timer Provides Appliance Control 128
Meter Has Ceramic Magnet and Printed-Circuit Coil 132
Magnetic Repulsion Bearings for Watt-Hour Meters 132
Optimizing Control Balances Bridge Network 134
Flexible-Ratio Gear Boxes 136
Variable-Resistance Transducer 138

August 1961

Tunnel-Diode Capacitance Measurements 118
High-Thermal-Conductivity Potting Compound Used in Canned Motor Pumps 119
Internal Light Source Operates Relay-Potentiometer 120
Continuous-Balance Potentiometer System Has Infinite Resolution 122
Rotary Switch Stores Multiple-Digit Numbers 124
Some Aspects of Shunt-Regulated Power Supplies 126
Low-Torque Tester 130

September 1961

Measuring Functional Accuracy of Hall-Effect Generators 134
A Band-Pass Filter Slide Rule 136
High-Speed Analog-to-Digital Converter 142
Optimal Electromagnet Design 144
Magnetic Flow-Meter 146

October 1961

Using the Silicon Controlled Rectifier for Protection 130
A Transient-Current Solenoid Driver 132
High-Efficiency-Choke Design 134
Russian D-C Motors Described 136
Transistor Tester Supplies Constant Collector Current 138
Thin-Film Precision Resistors through Photography 140
Simplified Evaluation of Electrical Insulation 142
Feedback Relationships in Transistor Amplifiers 146

November 1961

Measuring Power Factor of Non-Sinusoidal Waveforms 126
Mechanical-Property Considerations in Epoxy Insulation 127
Frictionless Pivot 130
Storing and Reforming Aluminum-Foil Electrolytic Capacitors 130
Housing Serves as Efficient Tube-Welder Secondary 132
Electro-Pneumatic Transducer 134

December 1961

A Complementary Symmetry Emitter-Follower 132
A-C/D-C High-Potential Testing 134
Universal-Motor Speed Controls 138
Water-Cooled Pipe for Generator Test Loading 142
Infrared Spectrometer with Increased Sensitivity 144

Authors' Index

	Month	Page
A		
Adler, E.		
Tunnel-Diode Capacitance Measurements	Aug	118
Alger, P. L.		
Electromechanical Energy Conversion	Sep	95
Appleman, W. R.		
Precise Variable-Speed, Constant-Frequency Alternator	Aug	63
Aron, N.		
The Weighted Resistor Decoder: An Error Analysis	Apr	154
Asten, W. P.		
Photoelectric Reader Senses Reflected Light Intensity	Mar	166
B		
Barkan, H. E.		
Advances in Magnetism and Magnetic Materials	Feb	80
Solders—Their Function in Designing Aluminum Parts	Apr	101
The Design Analysis of Materials	May	136
Wear of Materials—Impact on Design Failure	Jul	95
Barnes, T. D.		
Magnetic Repulsion Bearings for Watt-Hour Meters	Jul	132
Baum, J. R.		
Thermal-Design Considerations in Thin-Film Microelectronics	Jul	92
Bekey, A.		
New High-Performance Designs for Small Synchronous Motors	Nov	85
Ben Uri, J.		
Variable-Speed Control Systems	Mar	91
Benedict, R. P.		
Transient Heat Flow	Dec	93
Benson, R. J.		
Factors Contributing to Backlash in Gear Trains	Jul	66
Berman, B.		
Magnetic-Amplifier Design for Remote Locations	Mar	157
Blinchikoff, H. J.		
A Band-Pass Filter Slide Rule	Sep	136
Block, P.		
Automatic Switching Control with Electric Clutches and Brakes	Dec	84
Boas, M. L.		
Vector Analysis	Jun	91
Tensor Analysis	Aug	85
Bouche, R. R.		
Shock/Vibration Testing Gains Speed and Precision: 2. Calibration of Shock/Vibration Pickups	May	92
Bowen, H. M.		
Engineering Psychology and Human Factors in Design	May	108
Boynton, R.		
Shock/Vibration Testing Gains Speed and Precision: 1. The MB Electronics Spectrum Analyzer	May	90
Brazda, J.		
Coded Time-Pulse Circuits for Data Correlation	May	156
Brennan, J. J.		
Electrical Stability of Clay-Loaded Butyl Insulation Compounds	Mar	12
Brown, W. J.		
Firing Circuits for Silicon Controlled Rectifiers	Jul	79
Bryant, F.		
Low-Cost Tachometer Generator	May	155
C		
Cameron, C. F.		
Method for Experimental Study of Relay Stability	Mar	156
Carroll, J. T.		
Relay Characteristics Amplified	Mar	160
Case, C. E.		
Multiple-Input Frequency Changer	Feb	144
Chaikin, S. W.		
Mechanics of Electrical-Contact Failure Caused by Surface Contamination	Aug	70
Chambers, A. N.		
Human-Factors Engineering Design Standards	Aug	103
Chellis, L. N.		
Flame Resistance of Plastics—A Key "Design-for-Safety" Factor	Dec	77
Chenzoff, A. P.		
Engineering Psychology and Human Factors in Design	May	108
Christian, J. L.		
Cryogenics: Selection Data for Structural Materials	Nov	76
Clark, J. J.		
Effects of Temperature on Magnetic Properties of Cobalt-Iron Alloys	Oct	93
Collins, F. R.		
Solders—Their Function in Designing Aluminum Parts	Apr	101
Copella, J. C.		
Water-Cooled Pipe for Generator Test Loading	Dec	142
Cordts, H. P.		
Ultrahigh-Temperature Plastics with Reactive Diphenyl Oxides	Jul	14
Crawford, F.		
Digital Matchers	Nov	113
Curran, J. E.		
Electrical Noise Control	Dec	117
D		
Dacey, G. C.		
Quantum Electronics	Apr	109
Davis, J. F.		
Russian D-C Motors Described	Oct	136
Davis, J. P.		
Spring Design for Electronic Equipment	Apr	121
Delmonte, J.		
Mechanical-Property Considerations in Epoxy Insulation	Nov	127
Devins, J. C.		
The Fundamental Nature of Electrical Breakdown	Feb	103
Electrical Breakdown in Solids and Liquids	Oct	97
Diebold, E. J.		
Semiconductor Rectifier Characteristics	Jun	72
Doctor, N. J.		
Miniature Digital-Program Timer	Feb	142
Doedens, J. D.		
Ultrahigh-Temperature Plastics with Reactive Diphenyl Oxides	Jul	14
Drennan, J. E.		
Summary of Nuclear Radiation Effects on Electronic Components and Systems	Mar	132
Dummer, G. W. A.		
Analyzing Failure Rates in Electronic Components	Feb	89
Dunlap, J. W.		
Engineering Psychology and Human Factors in Design	May	108

	Month	Page

E

Ehrenpreis, D. B.
Dollar Trade-Offs in Systems Design Involve Total Engineering — May 78

Ely, J. H.
Engineering Psychology and Human Factors in Design — May 108

Epstein, D.
Transformer Specification for Reliable Electronic Equipment — Oct 76

Erdelyi, E.
Electromechanical Energy Conversion — Sep 95

Eskin, H.
Variable-Resistance Transducer — Jul 138

Esposito, S. M.
Shielding Electronic Circuits against Nuclear Radiation — Jun 12

F

Fekete, R.
A Technique for Measuring High-Frequency Transistor Characteristics — Jan 126

Flanagan, C. D.
Continuous-Recording Temperature-Measurement by Resistance — Apr 158

Frank, W.
Arc Suppression for Contact Protection — Jun 134

Freeny, C. C.
Method for Experimental Study of Relay Stability — Mar 156

Frisco, L. J.
Frequency Dependence of Electric Strength—a Design Consideration Analysis — Aug 110

Fritz, J. F.
Effects of Temperature on Magnetic Properties of Cobalt-Iron Alloys — Oct 93

G

Gebel, I.
A-C Solenoid Application — Oct 117

Ghaznavi, C.
Wound Cores Improve Transformer Performance — Jun 67

Giuffria, R.
Microscopy Techniques for Study of Magnet-Wire Insulation — Apr 11

Gordon, D. I.
Environmental Evaluation of Magnetic Materials — Jan 118

Gordon, S. H.
Miniature Digital-Program Timer — Feb 142

Goundry, R. A.
The Weighted Resistor Decoder: An Error Analysis — Apr 154

Greenblatt, R. C.
A Transient-Current Solenoid Driver — Oct 132

Greene, K.
Exceeding Resistor Power Ratings — Apr 156

Gresh, M.
Niobium Solid-Electrolytic Capacitors — Sep 12

Gruber, A.
Engineering Psychology and Human Factors in Design — May 108

Gutzwiller, F. W.
Using the Silicon Controlled Rectifier for Protection — Oct 130
Universal-Motor Speed Controls — Dec 138

H

Hall, D. W.
Metal-Bonded Graphite for Electromechanical Applications — Apr 10

Hand, W.
Electrical Analog for Vibration-Damping Measurements — Nov 117

Hanson, W. M.
Thermal Classification of Pressure-Sensitive Adhesive Electrical Tapes — Jan 113

Harac, S.
Measuring Functional Accuracy of Hall-Effect Generators — Sep 134

Harnden, J. D., Jr.
Solid-State Devices in Appliance Control—A Projection — Nov 121

Harper, C. A.
Thermally Conductive Cast-Resin Compounds for Heat Dissipation — Apr 148

Harris, B.
The Forum: Computing Machines in Control Systems—Panel Discussion — Mar 145

Hayden, J. H.
Storing and Reforming Aluminum-Foil Electrolytic Capacitors — Nov 130

Hennings, D.
Automatic Switching Control with Electric Clutches and Brakes — Dec 84

Hershberg, P. I.
Electronic Devices in Simulation of Neuron Networks — May 10

Hertz, J.
Cryogenics: Selection Data for Structural Materials — Nov 76

Hilton, A. M.
Probability, Statistics and the Theory of Games — Mar 101
The Forum: Computing Machines in Control Systems—Panel Discussion — Mar 145

Hoglund, G. O.
Solders—Their Function in Designing Aluminum Parts — Apr 101

Holladay, R. A.
Semiconductor Failure Analysis Using Characteristic Curves — Aug 76

Hooper, C. K.
Voltage Relationships in a Simplified Controlled Three-Phase D-C Rectifier — May 164
Bleeder-Resistance Considerations in Single-Phase Rectifiers — Jun 144

Huang, J. S. T.
Feedback Relationships in Transistor Amplifiers — Oct 146

Hudrlik, R. E.
Thermal Classification of Pressure-Sensitive Adhesive Electrical Tapes — Jan 113

Humenik, M., Jr.
Metal-Bonded Graphite for Electromechanical Applications — Apr 10

Humphreys, G. W.
Relay Contact Plating Sensing Circuit — Feb 144

Hunter, E. T.
Shielding Electronic Circuits Against Nuclear Radiation — Jun 12

Hupert, J. J.
Vector Analysis — Jun 91
Tensor Analysis — Aug 85

I

Isken, J. R.
Derating—Its Meaning and Limitations — Jun 80

J

Jackson, S. P.
Saturable-Reactor Control of D-C Motors — Jul 103

Janowiak, R. M.
Flexible Ceramic Dielectrics — Aug 13

Javitz, A. E.
Stability of Epoxy-Encapsulated Magnet-Wire Systems—An Analysis of Compatibility Factors — Mar 82
Engineering Psychology and Human Factors in Design — May 107
The Design Analysis of Materials — May 136
Key Problems in Microelectronics — Jun 61
Cryogenics: Environment/Phenomena/Applications — Sep 121

	Month	Page

K

Karlik, S.
Niobium Solid-Electrolytic Capacitors ..... Sep 12
Kasparian, C.
Shading Coils Energized for Motor Control ... Oct 120
Kelley, C. R.
Engineering Psychology and Human Factors in Design ..... May 108
Kelley, J. B.
How to Make Basic D-C Measurements—2 .. Apr 138
Kestenbaum, R.
Global Communications—State of the Art .... Nov 62
King, D. E.
Relay Characteristics Amplified ..... Mar 160
Klouda, J. C.
Practical Aspects in Evaluating Shielded Rooms Jun 138
Knapp, W. R., Jr.
Small Encoder Offers Fine Angular Resolution Feb 140
Kraus, A. D.
Bessel and Gamma Functions ..... Jan 74
Extended Surfaces for Heat Transfer: 1—Longitudinal Fins of Rectangular Profile ..... Feb 72
Extended Surfaces for Heat Transfer: 2—Radial Fins of Rectangular Profile ..... Mar 94
Extended Surfaces for Heat Transfer: 3—Longitudinal Fins of Non-Rectangular Profile ... Apr 129
Extended Surfaces for Heat Transfer: 4—Optimum Shapes for Longitudinal Fins and Radial Fins of Hyperbolic Profile ..... Jun 111
Extended Surfaces for Heat Transfer: 5—Spines Jul 107
Hyperbolic Functions ..... Oct 87

L

Lackey, R. S.
Thermoelectric Refrigeration and its Application ..... Jan 68
Langill, A. W., Jr.
Techniques of Analog Simulation ..... Dec 70
Lee, R.
Designing Electronic Transformers on a Digital Computer ..... May 147
Leonard, M. G.
Graphical Flux Analysis in Transformer Design Oct 122
Leslie, R. E.
Digital Matchers ..... Nov 113
Linden, E. G.
Aerospace Electronic Materials—Applications/Environments/Effects ..... Dec 125
Lindena, S.
Design of a Magnetic Voltage Stabilizer ..... May 154
Lindstrom, T.
Optimal Electromagnet Design ..... Sep 144
Lingelbach, D. D.
Method for Experimental Study of Relay Stability ..... Mar 156
Liss, S.
Precise-Angle Indicator ..... Jul 126
Long, A. L.
Shielding Electronic Circuits against Nuclear Radiation ..... Jun 12

M

McKelvie, J. L.
The Forum: Computing Machines in Control Systems—Principles of Data Processing in Numerical Control of Machine Tools ..... Mar 135
The Forum: Computing Machines in Control Systems—Panel Discussion ..... Mar 145
Macha, E. A.
High-Thermal-Conductivity Potting Compound Used in Canned Motor Pumps ..... Aug 119
Mackworth, N. H.
Engineering Psychology and Human Factors in Design ..... May 108
Maley, G. A.
Simplifying Switching Circuits with Boolean Algebra ..... May 101
Matsa, S. M.
The Forum: Computing Machines in Control Systems—Panel Discussion ..... Mar 145
Matthews, R.
Instrument-Motor Temperature-Rise Factors... Jan 132
May, M. S.
Water-Cooled Pipe for Generator Test Loading Dec 142
Maykuth, D. J.
Applications of Tantalum in Electronic Design Jun 129
Meister, J. B.
Stroboscopic Digital Readout ..... May 162
Merrill, F. W.
The Permanent-Field Synchronous Motor ..... Dec 113
Meyers, M. M.
Relay Designers and Users Meet ..... Jul 74
Miller, H. N.
A-C/D-C High-Potential Testing ..... Dec 134
Mintz, L.
Design of Reversible Magnetic Shift Registers Aug 66
Moraski, E.
Selecting Balancing Motors for Measuring Systems ..... Aug 80
Moredock, A. E.
Copper-Base Alloy Spring Materials ..... Sep 76
Morgan, H. L.
High-Efficiency-Choke Design ..... Oct 134
Morton, W.
Quiet Wiring ..... Mar 78
Murphy, R. M.
Solid-State Sequence Timer Provides Appliance Control ..... Jul 128

N

Newhouse, V. L.
Superconductive Circuits for Computing Machines ..... Apr 78

O

O'Brien, R. A.
Materials Evaluation in Printed-Circuit-Board Design ..... Apr 162
Oliver, F. J.
The Forum: Computing Machines in Control Systems—Panel Discussion ..... Mar 145
Olyphant, M., Jr.
Effects of Corona on Vinyl Electrical Tape... Jun 123
Opp, F.
Transistor Choppers ..... Feb 141

P

Penn, W. B.
Simplified Evaluation of Electrical Insulation Oct 142
Pepler, R. D.
Engineering Psychology and Human Factors in Design ..... May 108
Peters, R. L.
Resistance-Temperature Nomograph ..... Mar 158
Platzer, G. E., Jr.
A Procedure for the Design of Transistor Bias Networks ..... Apr 97
Pohl, H. A.
Organic Semiconductors—A Research Report May 85
Powers, K. W.
Electrical Stability of Clay-Loaded Butyl Insulation Compounds ..... Mar 12
Preusser, P.
Human-Factors Engineering Design Standards Aug 103
Price, W. H., II
A Proportional Logic System ..... Feb 138
Purvis, R. S.
Brush Threading and Selective Action Related to Current Distribution ..... Mar 164

R

Randall, E.
Unconventional Power Sources—1 ..... Aug 54
Unconventional Power Sources—2 ..... Sep 85

	Month	Page
Richardson, I.		
The Technique of Transformer Design	Jan	58
Riggs, J. R.		
Digital Logic Modules	Sep	64
Roberts, B. W.		
Electron-Momentum Determination with Sound Waves	Jan	12
Robinson, A. S.		
The Forum: Computing Machines in Control Systems—Panel Discussion	Mar	145
Rodriguez, F.		
Electrical Stability of Clay-Loaded Butyl Insulation Compounds	Mar	12
Roehr, W. D.		
Transient Protection for High-Frequency Transistors	Sep	82
Rogers, V.		
The Forum: Computing Machines in Control Systems—Panel Discussion	Mar	145

S

Salz, N. P.		
Analytic Functions of a Complex Variable	Nov	93
Saulson, D. S.		
The Thermistor Bridge	Sep	73
Sawyer, B. L.		
Electrical Insulation System for 350 C Wafer-Coil Transformers	Feb	131
Schult, R. W.		
Electrochemical Energy Sources—Silver Oxide/Zinc Batteries	Jun	84
Electrochemical Energy Sources—Nickel/Cadmium Batteries	Jul	87
Schwartz, L. S.		
Reliability through Redundancy and Error-Correcting Codes	Feb	123
Probability, Statistics and the Theory of Games	Mar	101
Schwartz, N.		
Niobium Solid-Electrolytic Capacitors	Sep	12
Schwelb, O.		
Thermistor-Resistor Temperature-Sensing Networks	Nov	71
Seely, J. H.		
Effect of Ultrasonics on Natural-Convection Cooling Systems	Sep	12
Sharbaugh, A. H.		
The Fundamental Nature of Electrical Breakdown	Feb	103
Electrical Breakdown in Solids and Liquids	Oct	97
Simmons, C. D.		
Fast-Switching Transistor Operates at Micro-Energy Levels	Mar	162
Sollecito, W. E.		
Control System Analysis by Analog Simulation	May	131
Sorenson, A. A.		
Semiconductor Electronics: 4—Transistor Network Analysis	Jan	105
Semiconductor Electronics: 5—Transistor Amplifier Design	Feb	93
Semiconductor Electronics: 6—Non-Linear and Switching Operation	Mar	125
Digital-Circuit Reliability through Redundancy	Jul	118
Improving Analog-Circuit Reliability with Redundancy Techniques	Oct	66
Spalding, D. P.		
Heat-Run Slide Rule	Mar	168
Sprong, D. C.		
Dual-Purpose Digital Computer Is also Differential Analyzer	Apr	164
Staff Reports (see also under H. E. Barkan, A. M. Hilton, A. E. Javitz, R. Kestenbaum, M. M. Meyers, F. J. Oliver and J. R. Riggs)		
The Word is Reliability	May	94
Drive Developments Stressed at Machine Tool Forum	Jun	119
Combined Time-Temperature Data for Electrical/Electronic Laminates	Jul	116
Stafford, W. T.		
Electrochemical Energy Sources—Silver Oxide/Zinc Batteries	Jun	84
Electrochemical Energy Sources—Nickel/Cadmium Batteries	Jul	87

T

Taylor, C. J.		
Thin-Film Precision Resistors through Photography	Oct	140
Temes, G. C.		
Thermistor-Resistor Temperature-Sensing Networks	Nov	71
Tenzer, M.		
Trends in Semiconductor Devices for Microwave Applications	Oct	82
Tiner, J.		
Geneva Movement Provides Ten-Turn Rotary Switching	Apr	164
Tolcott, M. A.		
Engineering Psychology and Human Factors in Design	May	108
Human-Factors Engineering Design Standards	Aug	103
Torgow, E. N.		
Microwave Filters	Apr	90

V

Van Alsten, R. L.		
Metal-Bonded Graphite for Electromechanical Applications	Apr	10

W

Waller, H. H.		
Some Aspects of Shunt-Regulated Power Supplies	Aug	126
Walston, J. A.		
Transistor Choppers	Feb	141
Watson, J. F.		
Cryogenics: Selection Data for Structural Materials	Nov	76
Weed, H. R.		
Saturable-Reactor Control of D-C Motors	Jul	103
Weinberg, L.		
An Introduction to Network Synthesis	Jan	85
Network Synthesis: Some Notes on the Synthesis of RLC Transfer Functions and Constant-Resistance All-Pass Lattice Networks	Feb	135
Wendt, R. W., Jr.		
Optimizing Control Balances Bridge Network	Jul	134
Wilhelmson, D. A.		
Measuring Power Factor of Non-Sinusoidal Waveforms	Nov	126
Winding, C. C.		
Electrical Stability of Clay-Loaded Butyl Insulation Compounds	Mar	12
Witmer, R. C.		
Spline-Drive Armature in Rugged Magnetic Clutch and Brake Design	Mar	160
Wolff, S. S.		
Tests Confirm Merits of Non-Silicon Lamination Steel	Jul	84
Wonson, R. C.		
Tunnel-Diode Capacitance Measurements	Aug	118
Wright, W. L.		
Thermoelectric Refrigeration and its Application	Jan	68
Wyler, E. N.		
Summary of Nuclear-Radiation Effects on Electronic Components and Systems	Mar	132

Y

Yeoman, F. A.		
High-Thermal-Conductivity Potting Compound Used in Canned Motor Pumps	Aug	119
Yii, R.		
Design of Reversible Magnetic Shift Registers	Aug	66

	Month	Page
Z		
Ziffer, W.		
Improved Magnetoresistive Device	Feb	11
Zverev, A. I.		
A Band-Pass Filter Slide Rule	Sep	136

Alphabetical Subject Cross Index

Subject	*Classification*
A	
Acoustical Insulation	Materials, Mechanical/Structural (*Thermal and Acoustical Insulation*)
Adhesives	Materials, Mechanical/Structural
Automatic Assembly	Production and Assembly Techniques
B	
Batteries	Components, Electrical/Electronic
Bearings	Components, Mechanical/Structural
Boolean Algebra	Science & Engineering (*Mathematics*)
Brushes	Components, Electrical/Electronic (*Contact Devices*)
C	
Capacitors	Components, Electrical/Electronic
Casting Resins	Materials, Electrical/Electronic (*Electrical Insulation and Dielectrics*)
Castings	Materials, Mechanical/Structural (*Metals*)
Ceramic Dielectrics	Materials, Electrical/Electronic (*Electrical Insulation and Dielectrics*)
Ceramic-Metals	Materials, Mechanical/Structural (*Composite Materials*)
Cements	Materials, Mechanical/Structural (*Adhesives*)
Circuit Analysis	Science & Engineering (*Network Analysis*)
Circuit Breakers	Components, Electrical/Electronic (*Protective Devices*)
Clad Metals	Materials, Mechanical/Structural (*Metals*)
Coaxial Cable	Components, Electrical/Electronic (*Wire and Cable*)
Commutators	Components, Electrical/Electronic (*Contact Devices*)
Component Failure	Design Considerations (*Reliability*)
Component Testing	Test and Measurement
Composite Materials	Materials, Mechanical/Structural
Computer Design	Systems (*Computer-type Subsystems*)
Conductive Plastics	Materials, Electrical/Electronic (*Conductor Materials*)
Conductive Rubber	Materials, Electrical/Electronic (*Conductor Materials*)
Conductor Materials	Materials, Electrical/Electronic
Connections	Production and Assembly Techniques (*Soldering and Solderless Techniques*)
Connectors	Components, Electrical/Electronic (*Wiring Devices*)
Contact Devices	Components, Electrical/Electronic
Contact Materials	Materials, Electrical/Electronic (*Contact Materials*)
Control Instruments	Systems (*Control Systems, General*)
Cooling	Heat Flow
Corona Effects	Test and Measurement (*Materials*)
D	
Delay Lines	Components, Electrical/Electronic (*Storage Devices*)
Diodes	Components, Electrical/Electronic (*Semiconductor Devices*)
Drive Elements	Systems (*Power—Drives*), also Components, Mechanical/Structural
E	
Elastomers	Materials, Mechanical/Structural (*Non-metallic Materials*)
Electrical Drives	Systems (*Power—Drives*)
Electrical Insulation and Dielectrics	Materials, Electrical/Electronic
Electrodeposited Coatings	Materials, Mechanical/Structural (*Protective Coatings*)
Electronic Apparatus Design	Product Design Case History
Electron Tubes	Components, Electrical/Electronic
Embedded Circuits and Components	Production and Assembly Techniques
Encapsulation	Production and Assembly Techniques (*Embedded Circuits and Components*)
Engineering Psychology	Design Considerations (*Human Factors*)
Environmental Effects	Design Considerations
Environmental Tests	Test and Measurement (*Environmental*)
Equipment Failure	Design Considerations (*Reliability*)
F	
Fasteners	Components, Mechanical/Structural
Felt	Materials, Mechanical/Structural (*Non-metallic Materials*)
Ferrites	Materials, Electrical/Electronic (*Magnetic Materials*)
Finishes	Materials, Mechanical/Structural (*Protective Coatings*)
Flexible Insulation	Materials, Electrical/Electronic (*Electrical Insulation and Dielectrics*)
Fungicidal Treatment	Materials, Mechanical/Structural (*Protective Coatings*)
Fuses	Components, Electrical/Electronic (*Protective Devices*)
G	
Gaseous Dielectrics	Materials, Electrical/Electronic (*Electrical Insulation and Dielectrics*)
Gaskets	Components, Mechanical/Structural (*Seals and Gaskets*)
Gearmotors	Motors (*Special*)
Gears and Pinions	Components, Electrical/Electronic, also Systems (*Mechanical*)
Glass Dielectrics	Materials, Electrical/Electronic (*Electrical Insulation and Dielectrics*)
H	
Hermetic Sealing	Production and Assembly Techniques
Hookup Wire	Components, Electrical/Electronic (*Wire and Cable*)
Housings	Components, Mechanical/Structural
Human Factors Engineering	Design Considerations
Humidity Effects	Design Considerations (*Environmental Effects*)
I	
Impregnation	Production and Assembly Techniques (*Embedded Circuits and Components*)
Inductors	Components, Electrical/Electronic (*Magnetic Components*)
Industrial Machinery Design	Product Design Case History
Instrument Applications	Test and Measurement
Instrument Design	Product Design Case History, also Instruments and Test Equipment (*Design*)
Instrument Generators	Components, Electrical/Electronic (*Transducers*)
Insulation Testing	Test and Measurement (*Materials*)
International Standards	Specifications and Standards
L	
Laminates, Plastics	Materials, Electrical/Electronic (*Electrical Insulation and Dielectrics*)
Liquid Dielectrics	Materials, Electrical/Electronic (*Electrical Insulation and Dielectrics*)
Lubricants	Materials, Mechanical/Structural (*Non-metallic Materials*)

Subject	Classification
M	
Magnetic Amplifiers	Systems (*Control Systems, General*) also Components, Electrical/Electronic (*Magnetic Components*)
Magnetic Core Memories	Components, Electrical/Electronic (*Storage Devices*)
Magnetic Materials	Materials, Electrical/Electronic
Magnetic Recording	Components, Electrical/Electronic (*Transducers*), also Systems (*Recording*)
Magnet Wire	Components, Electrical/Electronic (*Wire and Cable*)
Maintainability	Design Considerations
Materials Testing	Test and Measurement
Mechanical Drives	Systems (*Mechanical*) also Components, Mechanical/Structural (*Drive Elements*)
Metalized Parts	Materials, Mechanical/Structural (*Composite Materials*)
Metal-Plastics Sheet	Materials, Mechanical/Structural (*Composite Materials*)
Metals	Materials, Mechanical/Structural
Meters, Panel-Type	Components, Electrical/Electronic
Microcircuit Assemblies	Components, Electrical/Electronic
Miniaturization	Design Considerations
Modular Construction	Design Considerations (*Miniaturization*)
N	
Nomographs	Science & Engineering (*Mathematics*)
Non-metallic Materials	Materials, Mechanical/Structural
Nuclear Radiation Effects	Design Considerations (*Environmental Effects*)
P	
Packaging, Electronic	Production and Assembly Techniques
Pickups, Electrical	Components, Electrical/Electronic (*Transducers*)
Plastics, Fabricated	Materials, Mechanical/Structural (*Non-metallic Materials*)
Plastics, Insulation	Materials, Electrical/Electronic (*Electrical Insulation and Dielectrics*)
Plastics, Molded	Materials, Mechanical/Structural (*Non-metallic Materials*)
Plated Coatings	Materials, Mechanical/Structural (*Protective Coatings*)
Porcelain Enamel	Materials, Mechanical/Structural (*Protective Coatings*)
Potentiometers	Components, Electrical/Electronic
Potting	Production and Assembly Techniques (*Embedded Circuits and Components*)
Powder Metal Parts	Materials, Mechanical/Structural (*Metals*)
Power Generators	Systems (*Power*)
Printed Circuits	Components, Electrical/Electronic
Printed Wiring	Production and Assembly Techniques
Printed Wiring Board	Components, Electrical/Electronic (*Printed Circuits*)
Production Tests	Test and Measurement
Protective Coatings	Materials, Mechanical/Structural
Protective Devices	Components, Electrical/Electronic
Q	
Quality Control	Test and Measurement
R	
Radio Noise and Interference	Design Considerations
Recording Instruments	Instruments and Test Equipment, also Systems (*Recording*)
Rectifiers	Components, Electrical/Electronic (*Semiductor Devices*)
Relays	Components, Electrical/Electronic (*Contact Devices*)
Reliability	Design Considerations
Resistance Wire	Materials, Electrical/Electronic (*Conductor Materials*)
Resistors	Components, Electrical/Electronic
Rigid Insulation	Materials, Electrical/Electronic (*Electrical Insulation and Dielectrics*)
S	
Sealants	Materials, Mechanical/Structural (*Adhesives*)
Seals and Gaskets	Components, Mechanical/Structural
Semiconductor Devices	Components, Electrical/Electronic
Sensing Elements	Components, Electrical/Electronic (*Transducers*)
Servos	Systems (*Control Systems, General*)
Sheet Metals	Materials, Mechanical/Structural (*Metals*)
Shielding Devices	Components, Electrical/Electronic
Shock and Vibration	Design Considerations (*Environmental Effects*)
Shock and Vibration Isolators	Components, Mechanical/Structural
Slip Rings	Components, Electrical/Electronic (*Contact Devices*)
Sockets	Components, Electrical/Electronic (*Wiring Devices*)
Soldering and Solderless Techniques	Production and Assembly Techniques
Solenoids	Components, Electrical/Electronic (*Magnetic Components*)
Springs	Components, Mechanical/Structural
Storage Devices	Components, Electrical/Electronic
Strength and Weight Factors	Design Considerations
Switches	Components, Electrical/Electronic
Systems, Testing	Test and Measurement
T	
Temperature Limits	Test and Measurement
Terminals	Components, Electrical/Electronic (*Wiring Devices*)
Test Equipment	Test and Measurement
Thermal and Acoustical Insulation	Materials, Mechanical/Structural
Thermal Design Factors	Design Considerations
Thermal Dissipation	Heat Flow
Thermistors	Components, Electrical/Electronic (*Semiconductor Devices*)
Thermostats	Components, Electrical/Electronic (*Transducers*)
Transducers	Components, Electrical/Electronic
Transformers	Components, Electrical/Electronic (*Magnetic Components*)
Transistors	Components, Electrical/Electronic (*Semiconductor Devices*)
U	
Unitized Construction	Production and Assembly Techniques
V	
Varnishes, Insulating	Materials, Electrical/Electronic (*Electrical Insulation and Dielectrics*)
W	
Waveguides	Components, Electrical/Electronic (*Microwave Components*)
Wire and Cable	Components, Electrical/Electronic
Wire Enamel and Insulation	Materials, Electrical/Electronic (*Electrical Insulation and Dielectrics*)
Wiring Devices	Components, Electrical/Electronic
Wiring Harness	Components, Electrical/Electronic (*Wire and Cable*)

Editorial Subject Classification

Science & Engineering
- Chemistry
- Mathematics
- Network Analysis
- Physics
- Systems

Components, Electrical/Electronic
- Batteries
- Capacitors
- Contact Devices
- Electron Tubes
- Embedded Circuits
- Magnetic Components
- Meters, Panel-type
- Microcircuit Assemblies
- Microwave Components
- Motors (classified separately)
- Potentiometers
- Power Sources
- Printed Circuits
- Protective Devices
- Resistors
- Semiconductor Devices
- Shielding Devices
- Storage Devices
- Switches
- Thermoelectric Devices
- Transducers
- Wire and Cable
- Wiring Devices

Components, Mechanical/Structural
- Bearings
- Drive Elements
- Fasteners
- Gears
- Housings
- Seals and Gaskets
- Shock and Vibration Isolators
- Springs

Computing Machines
- Applications

Design Considerations
- Cost Factors
- Environmental Effects
- Human Factors
- Maintainability
- Miniaturization
- Radio Noise and Interference
- Reliability
- Strength and Weight Factors
- Thermal Design Factors

Heat Flow

Instruments and Test Equipment
- Design

Materials, Electrical/Electronic
- Conductor Materials
- Contact Materials
- Electrical Insulation and Dielectrics
- Magnetic Materials
- Semiconductor Materials

Materials, Mechanical/Structural
- Adhesives
- Composite Materials
- Metals
- Non-metallic Materials
- Protective Coatings
- Thermal and Acoustical Insulation

Motors
- Fractional-Horsepower
- Instrument
- Integral-Horsepower
- Special

Product Design Case History

Production and Assembly Techniques
- Automatic Assembly
- Embedded Circuits and Components
- Hermetic Sealing
- Miscellaneous
- Printed Wiring
- Soldering and Solderless Techniques
- Unitized Construction

Specifications and Standards

Systems
- Communication
- Computer-type Subsystems
- Control Case Histories
- Control Systems, General
- Mechanical
- Power (Drives)
- Recording

Test and Measurement
- Components
- Environmental
- General
- Materials
- Production
- Systems